Physics 4C Practice Test Questions from Ch19-20

Name: _____

May 1, 2020

Please show your work! Answers are not complete without clear reasoning. When asked for an expression, you must give your answer in terms of the variables given in the question and/or fundamental constants.

Answer as many questions as you can, in any order. Books and notes are not allowed. Use any blank space to answer questions, but please make sure it is clear which question your answer refers to.

$g = 9.8\ \text{ms}^{-2}$

$P_0 = 1.013 \times 10^5\ \text{Pa} = 1\ \text{atm}$

$R = 8.314\ \text{J mol}^{-1}\ \text{K}^{-1}$

$k_B = 1.38 \times 10^{-23}\ \text{J/K}$

$N_A = 6.022 \times 10^{23}$

$m_p = 1.67 \times 10^{-27}\ \text{kg}$

$\sigma = 5.6696 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$

$1\ \text{cal} = 4.186\ \text{J}$

$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$

Fahrenheit to Celsius:
$([^\circ\text{F}] - 32) \div 1.8 = [^\circ\text{C}]$

Celsius to Fahrenheit:
$([^\circ\text{C}] \times 1.8) + 32 = [^\circ\text{F}]$

$e = 1 - \frac{1}{(V_1/V_2)^{(\gamma-1)}}$

$\int_v^{v+\text{dv}} N_v\,\text{dv} = \int_v^{v+\text{dv}} 4\pi N \left(\frac{m_0}{2\pi k_B T}\right)^{3/2} v^2 e^{-m_0 v^2/2k_B T}\,\text{dv}$

1. **[12pts]** A sample of a solid substance has a volume V_0 and a density ρ_0 at a temperature T_0. The specific heat capacity of the sample is c and the coefficient of volume expansion is β. The solid sample is heated at in air at constant pressure P_0. If the temperature of the substance is increased by an amount ΔT and it remains a solid,

   (a) find and expression for the new density of the substance. [4 pts]

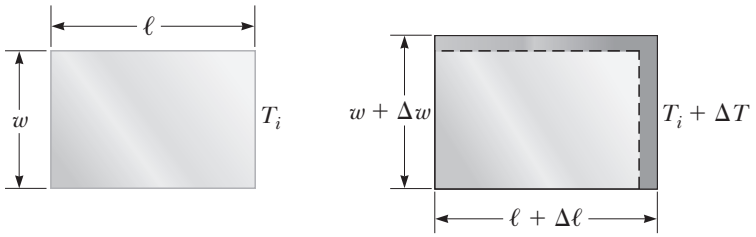
   (b) what is the work done on the sample as it is heated? [4 pts]

   (c) what is the change in the internal energy of the sample? [4 pts]

2. The rectangular plate shown has an area A_i equal to ℓw. For this plate α is the average coefficient of linear expansion.

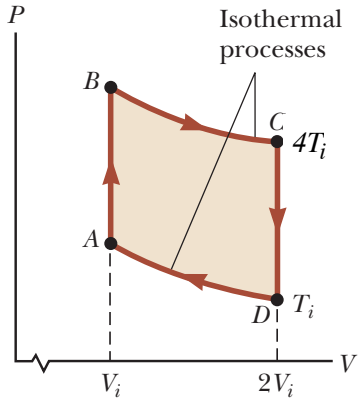
   (a) If the temperature increases by ΔT, show that the increase in area is $\Delta A = 2\alpha A_i \Delta T$. [5 pts]

   (b) What approximation does this expression assume? [1 pt]



3. A copper calorimeter with a mass of 250 g contains 500 g of water. The calorimeter and water are in thermal equilibrium at 15.0°C. A metallic block is placed into the water, which has a mass of 150.0 g and is originally at a temperature of 125°C. The entire system stabilizes at a final temperature of 20.0°C. The specific heat of copper is 387 J kg^{-1} $°C^{-1}$. Determine the specific heat of the unknown sample. [6 pts]

4. Consider n moles of an ideal gas being taken once through the (Stirling engine) cycle shown, consisting of two isothermal processes at temperatures $4T_i$ and T_i and two constant-volume processes.



(a) Find an expression for the net work done on the gas in a single complete cycle. [5 pts]

(b) What is the net heat transferred into the gas during a single complete cycle? [2 pts]